INTRODUCTION TO ELECTRONICS COURSE

Lecture - 1

Gourab Dutta

Syllabus ✓

SUBJECT NO-EC21103, SUBJECT NAME- Introduction to Electronics

LTP- 3-1-0,CRD- 4

SYLLABUS :-

Pre-requisites: None

Introduction to Electronic devices: passive devices, diode, bipolar junction transistor (BJT), metal oxide semiconductor field-effect transistor (MOSFET); Diode: basic structure and operating principle, current-voltage characteristic, large and small-signal models, iterative and graphical analysis; Diode Applications : rectifier circuits (half-wave and full-wave rectifiers, rectifiers with capacitor filter), voltage regulator (using Zener diode), clipper (limiter) circuits, clamper circuits; Bipolar Junction Transistors and their Applications: structure and modes of operation; n-p-n and p-n-p transistor in active mode, DC analysis of both transistor circuits; BJT as an amplifier, small-signal equivalent circuits, single-stage BJT amplifier (common-emitter mode); BJT as a switch; Metal Oxide Semiconductor Field-Effect Transistors and their Applications: structure and physical operation of n-type and p-type MOSFET; DC analysis of MOSFET circuits; MOSFET as an amplifier, small-signal equivalent circuits, single-stage MOSFET amplifier (common-source mode); MOSFET as a switch; Operational Amplifier (Op Amp) : ideal op amp; inverting amplifier, amplifier with a T-network, effect of finite gain, summing amplifier; non-inverting configuration, voltage follower; op amp applications like current-to-voltage converter, voltage-to-current converter, difference amplifier, instrumentation amplifier, integrator and differentiator; Feedback: basic concepts of negative feedback; four ideal feedback topologies; Oscillators: basic principles of sinusoidal oscillation; Example circuits; Digital Electronics: Boolean algebra and rules of simplification; combinational circuits like adder, decoder, encoder, multiplexer and demultiplexer; sequential circuits like flip-flops, counters and shift registers.

Course outline

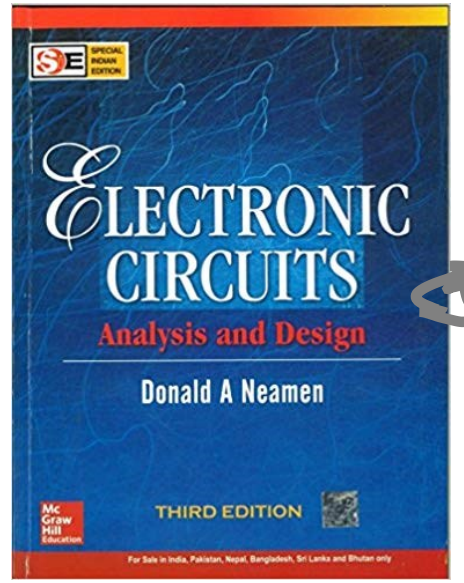
Major topics to be covered in this course:

1. Semiconductors and p-n junction diodes
2. Diode circuits
3. Filters (passive filters)
4. Bipolar Junction Transistor (BJT)
5. Basic BJT amplifiers
6. Field Effect Transistors (primarily MOSFETs)
7. Basic MOSFET amplifiers
8. Operational Amplifier (Op-Amp) and Op-Amp circuits
9. Digital Electronics (Boolean algebra, K-map, combinational and sequential circuits,…)
10. Oscillators*

* if time permits

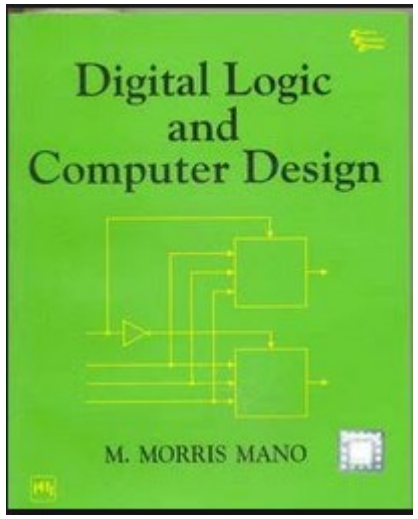
Books

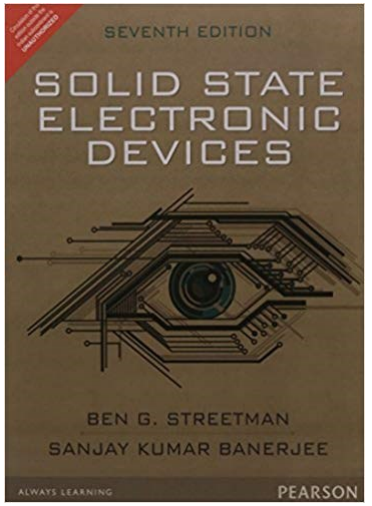
1. Electronic Circuits Analysis and Design – Donald A Neamen
2. Integrated Electronics – Jacob Millman and Christos Halkias
3. Digital Logic and Computer Design – M. Morris Mano
4. Solid State Electronic Devices – Ben. G. Streetman and S. Banerjee
5. The art of electronics – P. Horowitz and W. Hill

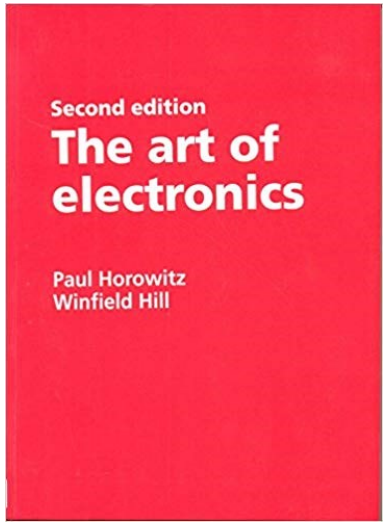


Text Book

Reference Books







What is Electronics??

Electronics: "The branch of physics and technology concerned with the design of circuits using transistors and microchips, and with the behavior and movement of **electrons** in a semiconductor, conductor, vacuum, or gas."*

"**Electronics** comprises the physics, engineering, technology and applications that deal with the emission, flow and control of electrons in vacuum and matter."**

Branches of electronics:

1. Digital Electronics
2. Microelectronics
3. Power Electronics
4. Optoelectronics
5. Telecommunications
6. Analog Electronics
7. Nanoelectronics etc…

*en.oxforddictionaries.com **wikipedia.org

Electronic components

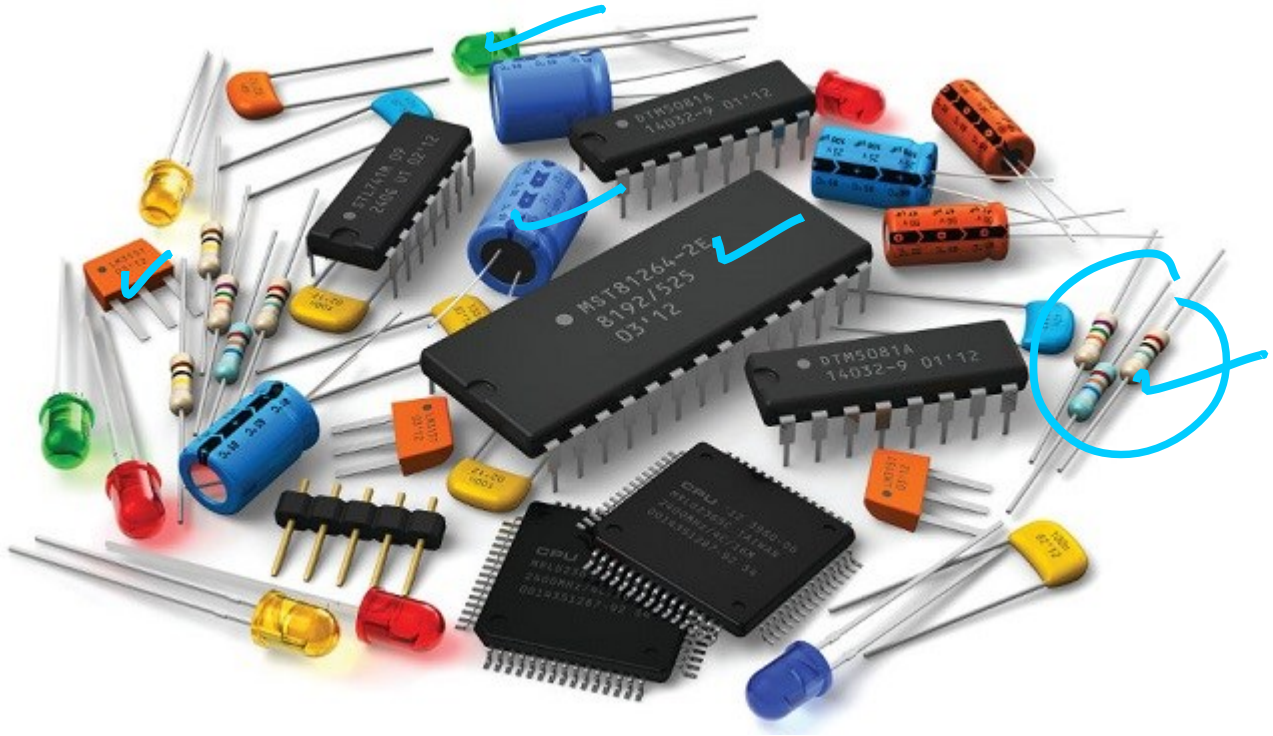


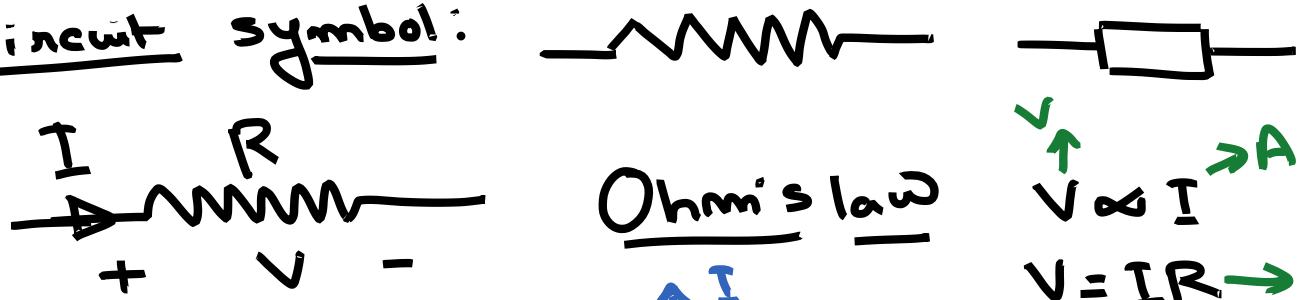
Image source: www.eletimes.com

Resistors

Resistor is a passive two-terminal circuit element that implements electrical resistance.

? Active vs Passive

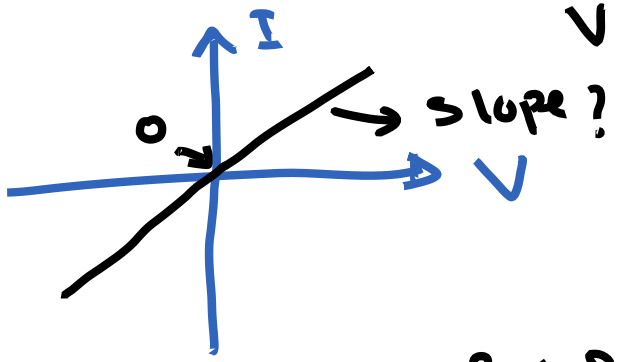
Circuit symbol:

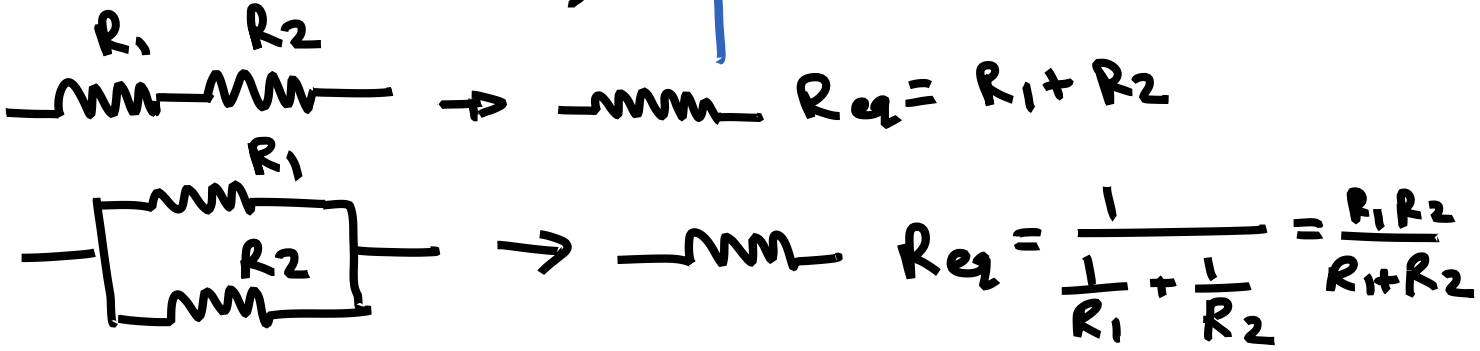


Ohm's law

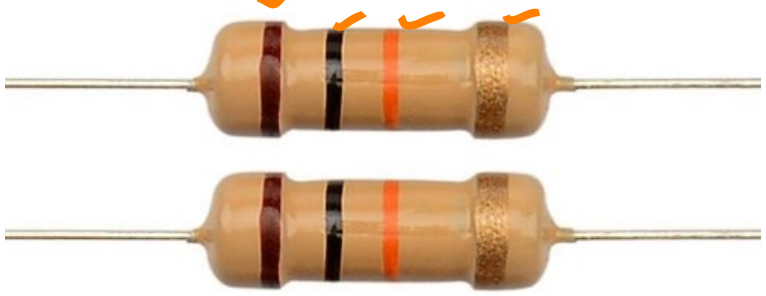
$V \propto I$

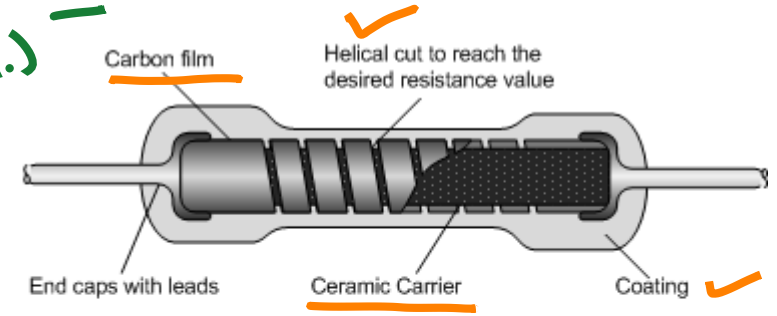
$V = IR$ → Ohm or Ω (S.I.)

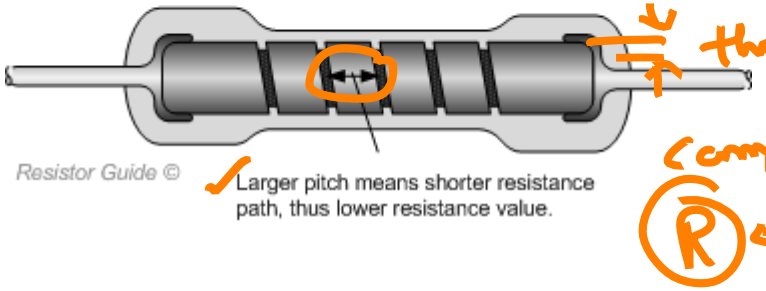




Fixed value resistors

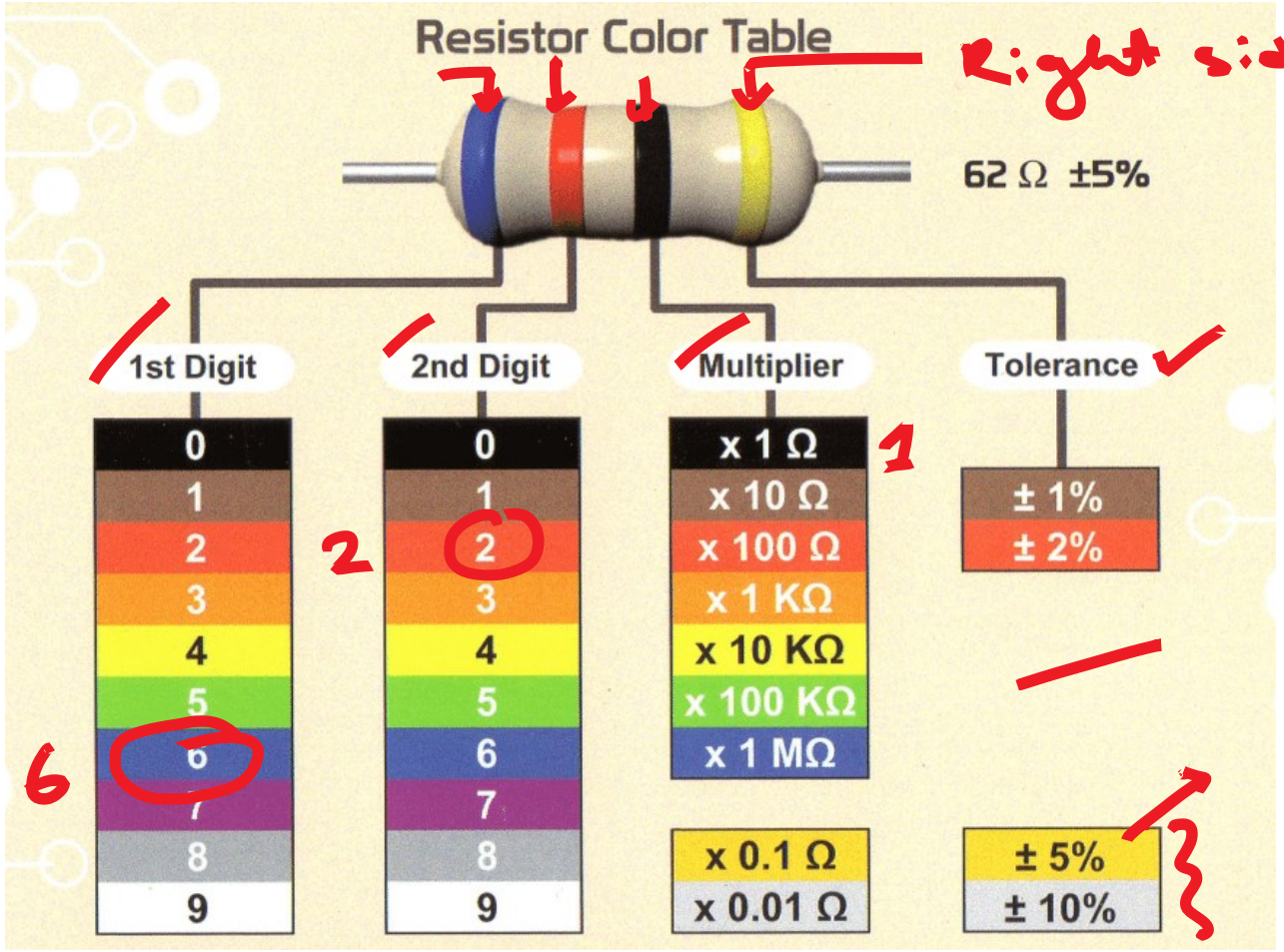






Source: www.resistorguide.com/carbon-film-resistor

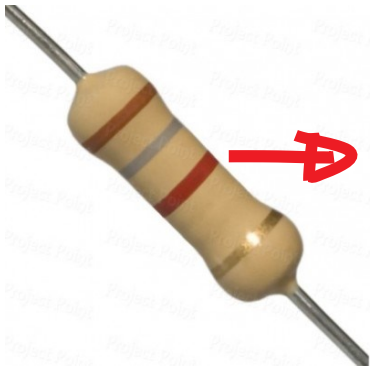
Resistors



Right side

10 x 100 Ω ± 5%

= 1 KΩ ± 5%



18 x 100 Ω ± 5%

= 1.8 KΩ

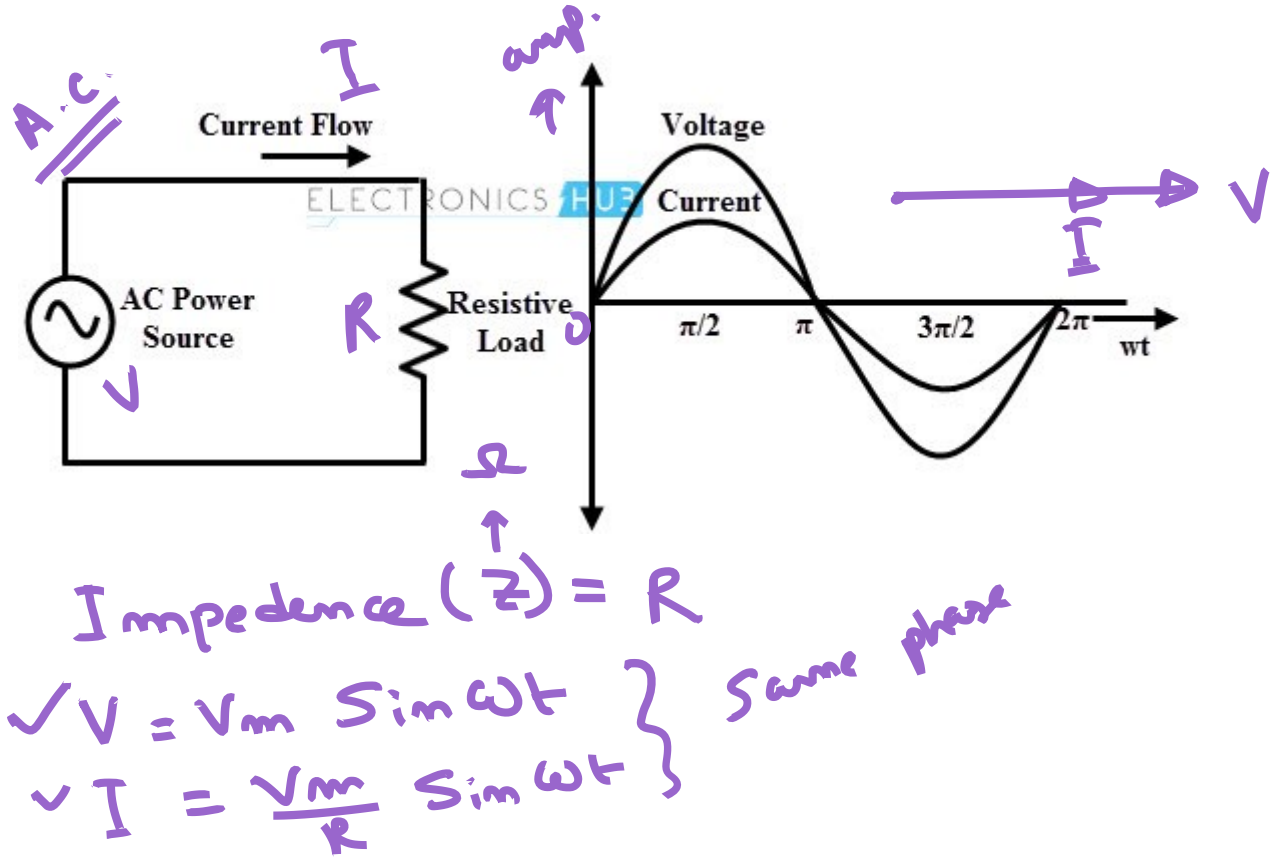
R = 62 x 1 Ω ± 5% = 62 Ω ± 5%

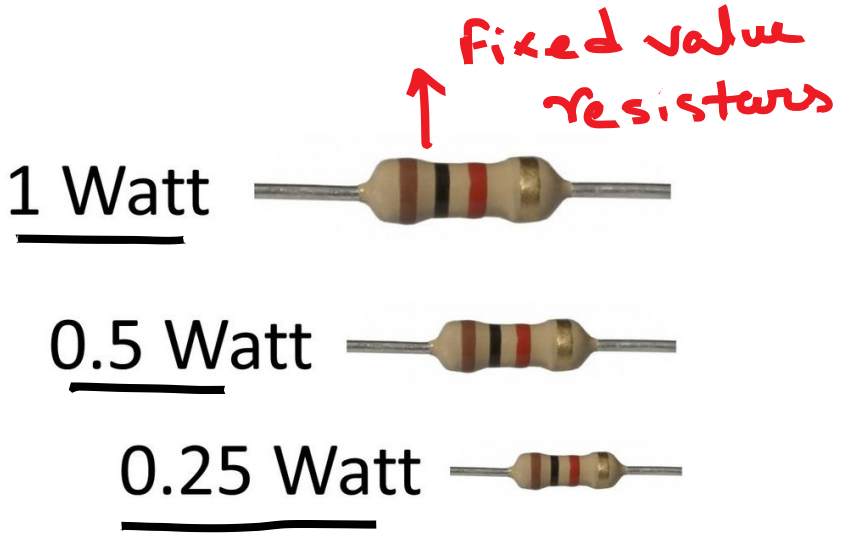
Image source: www.electronicsforu.com/

Resistors

Power = I × V = I^2R → heat → temp ↑

↳ Wattage of Resister





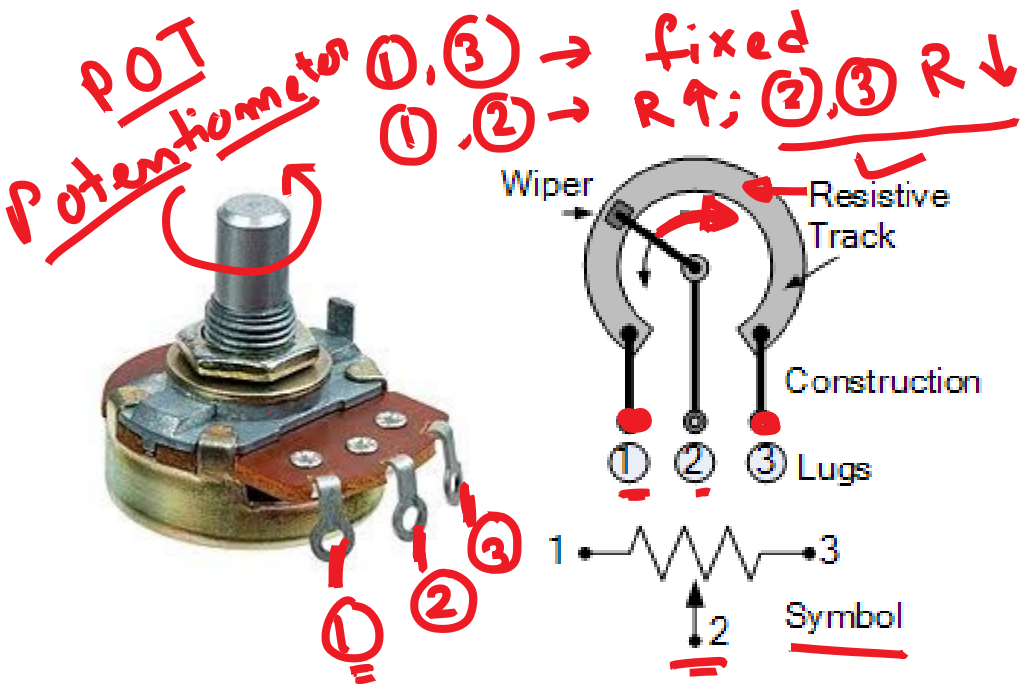
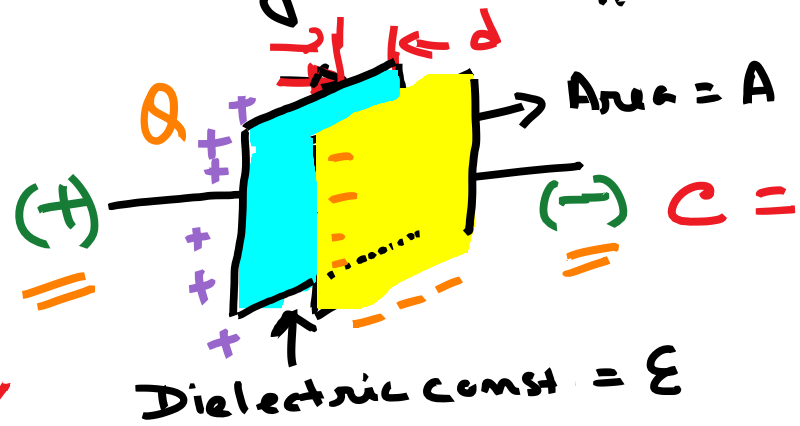


Image source: wikipedia.org, www.electronics-tutorials.ws, www.electronicshub.org

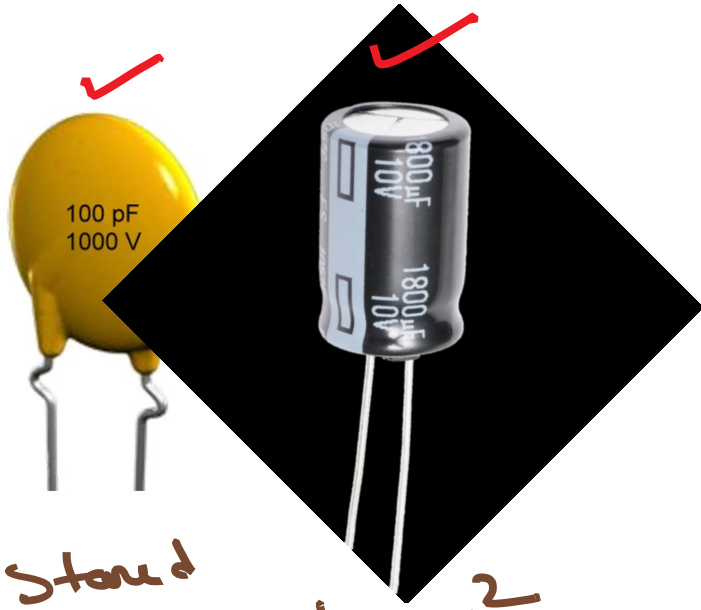
Capacitors

A **capacitor** is a two-terminal passive electronic component that stores energy in an electric field.

Circuit symbol: ⊣⊢ → Capacitance (Farad / F)

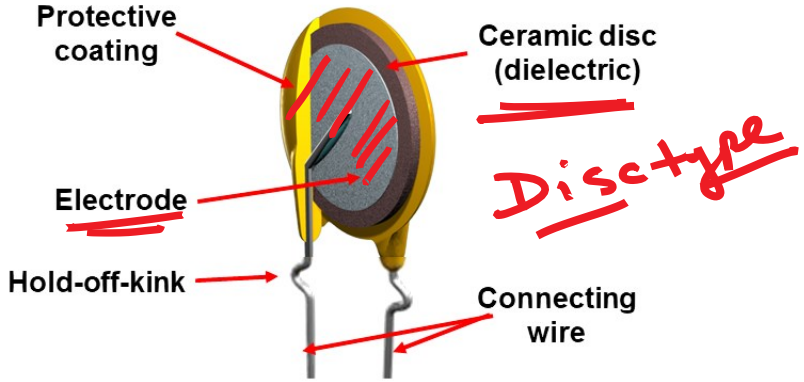


$C = \frac{\varepsilon A}{d}$; $C = \frac{Q}{V}$ ← applied voltage



Stored Energy = $\frac{1}{2} CV^2$

Ceramic capacitor



Disc type

Multilayer ceramic chip capacitor (MLCC)

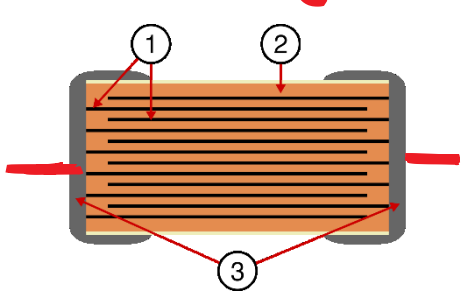
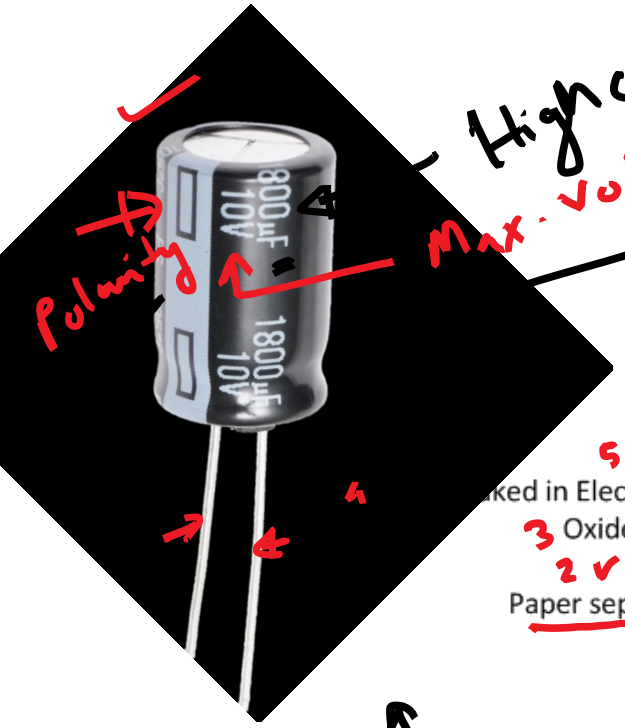


Image sources: panasonic.com and wikipedia.org

Capacitors

Electrolytic capacitor

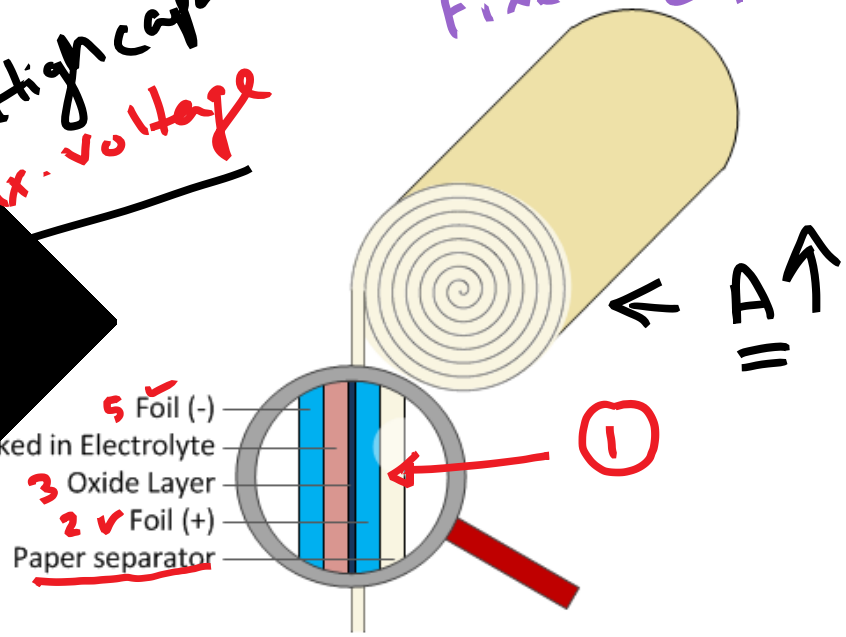


High capacitance

Max. voltage

Polarity

Fixed value capacitor



A ↑

1

$C = \frac{\epsilon A}{d}$

oxide

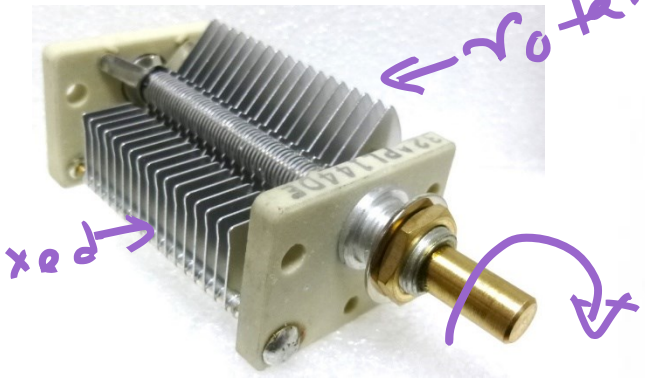
(−)

(+)

Dielectric

C ↑ (thin, uniform)

Variable capacitor



Rotating

Fixed

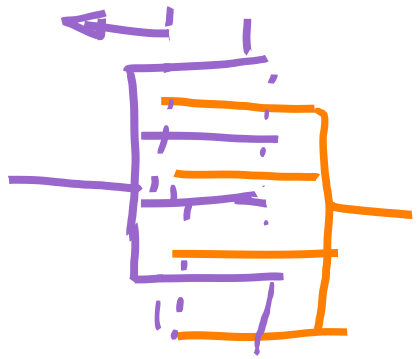
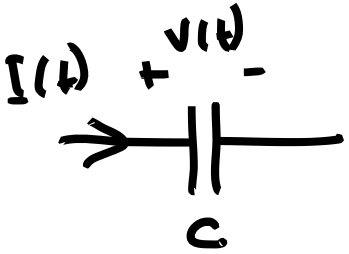
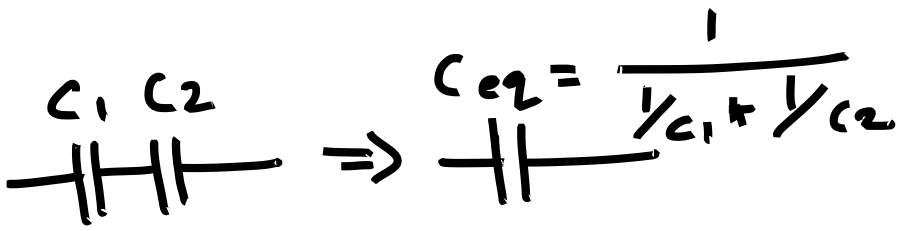


Image sources: panasonic.com, capacitorguide.com, www.rfparts.com/32apl144de.html and electromegamart.com

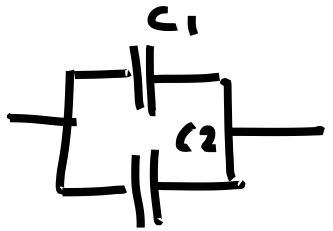
Capacitors

✓Current - voltage relationship, $I(t) = C \frac{dV(t)}{dt}$



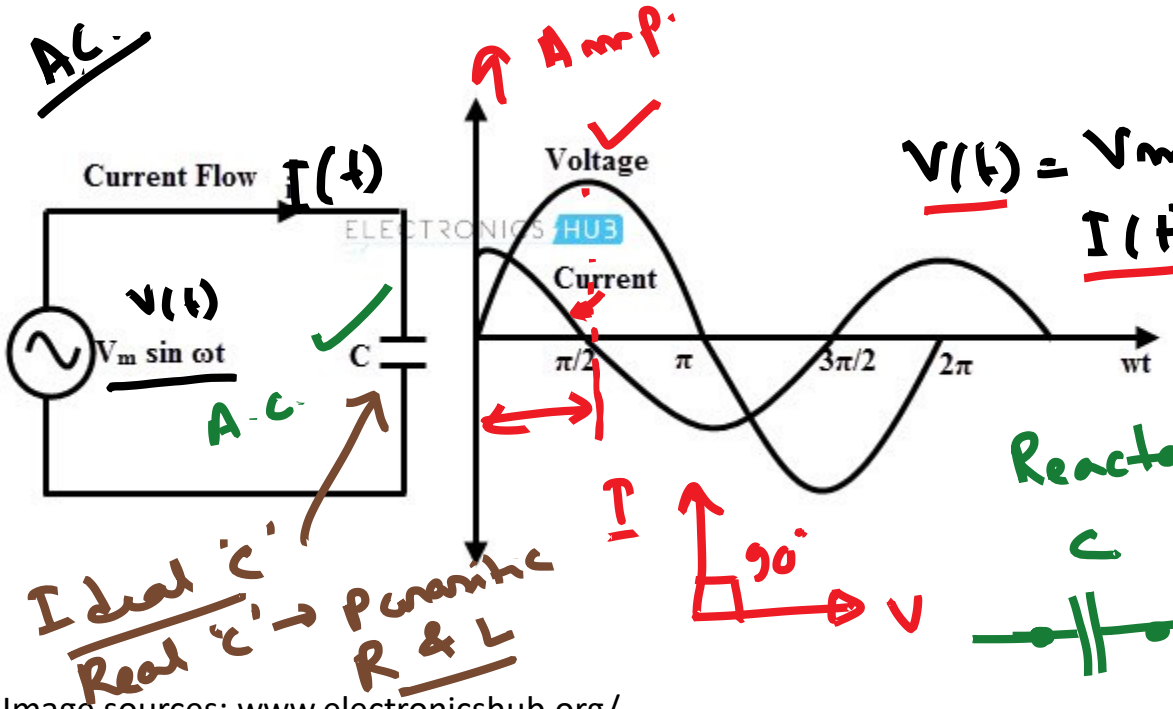


$\Rightarrow C_{eq} = \frac{1}{1/C_1 + 1/C_2}$



$\Rightarrow C_{eq} = C_1 + C_2$

AC



$V(t) = V_m \sin \omega t$

$I(t) = \omega C V_m \cos \omega t = \omega C V_m \sin(\omega t + 90^\circ)$

Current leads voltage by 90°

$\text{Reactance } (X_C) = \frac{1}{\omega C} = \frac{1}{2\pi f C}$; f ↑, X_C ↓

Short — when f is very high

Open — when f ≈ 0, DC

Image sources: www.electronicshub.org/